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1 Mixing state and absorbing properties of black carbon during Arctic haze

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The Arctic atmosphere is periodically affected by the Arctic haze occurring in spring. One of its particulate components is the black carbon (BC), which is considered to be an important contributor to climate change in the Arctic region. Beside BC-cloud interaction and albedo reduction of snow, BC may influence Arctic climate interacting directly with the solar radiation, warming the corresponding aerosol layer (Flanner, 2013). Such warming depends on BC atmospheric burden and also on the efficiency of BC to absorb light, in fact the light absorption is enhanced by mixing of BC with other atmospheric non-absorbing materials (lensing effect) (Bond et al., 2013). The BC reaching the Arctic is evilly processed, due to long range transport. Aging promote internal mixing and thus absorption enhancement. Such modification of mixing and is quantification after long range transport have been observed in the Atlantic ocean (China et al., 2015) but never investigated in the Arctic.
During field experiments conducted at the Zeppelin research site in Svalbard during the 2012 Arctic spring, we investigated the relative precision of different BC measuring techniques; a single particle soot photometer was then used to assess the coating of Arctic black carbon. This allowed quantifying the absorption enhancement induced by internal mixing via optical modelling; the optical assessment of aged black carbon in the arctic will be of major interest for future radiative forcing assessment.Optical characterization of the total aerosol indicated that in 2012 no extreme smoke events took place and that the aerosol population was dominated by fine and non-absorbing particles. Low mean concentration of rBC was found (30 ng m-3), with a mean mass equivalent diameter above 200 nm. rBC concentration detected with the continuous soot monitoring system and the single particle soot photometer was agreeing within 15%. Combining absorption coefficient observed with an aethalometer and rBC mass concentration from SP2, a mass absorption cross section of 6.0 m2 g-1 was found at a wavelength of 880 nm. Concerning mixing, rBC cores with a dimeter between 170 nm and 280 nm were found to be covered by a layer of non-absorbing material having a median thickness of 50 nm. From Mie calculation, such mixing would lead to an enhancement of absorption of 46% compared to a bare BC core. The aforementioned absorption enhancement would lead to a net decrease of single scattering albedo of the total aerosol of less than 1%. The reliability of Mie approach was confirmed by agreement with observations, while MAC values commonly used in radiative forcing models might lead to discrepancies up to 80%. Our work provides all the major optical properties of total aerosol and BC to minimize the uncertainty of radiative estimations based on a priori assumptions.